

Claims

1. A method for the deposition of a multi element thin film phosphor
5 composition onto a substrate, the method comprising;
- sputtering a single composite target having two component phases in a low pressure sputtering atmosphere comprising gases containing reactive species and non-reactive species, said two component phases containing metallic and non metallic materials that
10 contribute to the phosphor composition; and
 - varying the pressure of said reactive species within said sputtering atmosphere to control the sputtering rate of said two component phases of said composite target to cause the ratio of the elements in said two component phases to deposit in a desired ratio as a
15 phosphor film on said substrate.
2. The method of claim 1, wherein said pressure of said reactive species within said sputtering atmosphere is adjusted in accordance with the ratio of an exposed surface area of the two component phases of said
20 composite target in an active sputtering zone to cause the ratio of the metallic and non metallic materials in said phases to deposit as a phosphor film in a desired ratio on a substrate.
- 25 3. The method of claim 2, wherein said composite sputtering target is provided such that the ratio of an exposed surface area of the phase containing metallic materials to the phase containing non-metallic materials in the active sputtering zone remains substantially constant during sputtering of said composite target and is in the range of about 0.1
30 to 0.7.

4. The method of claim 3, wherein said ratio is in the range of about 0.2 to 0.6.
5. The method of claim 1, wherein said reactive species comprises
5 hydrogen sulfide, atomic sulfur and/or diatomic sulfur.
6. The method of claim 6, wherein said non-reactive species comprises one or more inert gases.
- 10 7. The method of claim 6, wherein said inert gas is selected from the group consisting of argon, nitrogen and mixtures thereof.
8. The method of claim 1, wherein said pressure is about 0.05Pa to about 0.3Pa.
- 15 9. The method of claim 1, wherein sputtering is conducted at a power density of about 3 to 5 watts per cm².
10. The method of claim 2, wherein said metallic materials are selected
20 from the group consisting of a metal and a thermally and electrically conductive metal alloy.
11. The method of claim 10, wherein said metal is selected from the group consisting of aluminum, gallium and indium.
- 25 12. The method of claim 2, wherein said non metallic materials comprise chemical compounds selected from the group consisting of sulfides, oxysulfides and oxides of an element from Group IIA or IIB of the Periodic Table of Elements and a rare earth element.

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13. The method of claim 12, wherein said rare earth element is selected from the group consisting of europium, terbium and cesium.

14. The method of claim 1, wherein said composite target comprises
5 two component phases selected from the group consisting of:

- a matrix phase and an inclusion phase; and
- two matrix phases;
- wherein one of said phases comprises one or more metallic materials that contribute to the phosphor composition and the other of
10 said phases comprises the remaining non metallic materials that contribute to the phosphor composition.

15. The method of claim 14, wherein said matrix phase comprises a metallic matrix of aluminum and said inclusion phase comprises a rare
15 earth doped alkaline earth sulfide.

16. The method of claim 14, wherein said composite sputtering target comprises a matrix phase provided as a metallic disc having an engraved surface of grooves containing said inclusion phase.
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17. The method of claim 16, wherein said grooves are substantially parallel.

18. The method of claim 17, wherein said grooves are about 2-3 mm
25 wide and spaced about 3 mm apart.

19. The method of claim 16, wherein said grooves are substantially concentric.

30 20. The method of claim 19, wherein said grooves are about 5-6 mm wide and spaced about 2 mm apart.

21. The method of claim 14, wherein said inclusion phase is provided as a porous plaque having pores filled with said matrix phase that comprises a metal or metal alloy.

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22. The method of claim 14, wherein said inclusion phase is in the form of discrete metallic bodies selected from pellets or spheres provided in a non-metallic matrix.

10 23. The method of claim 1, wherein said thin film phosphor composition is an alkaline earth thioaluminate phosphor.

24. The method of claim 23, wherein said phosphor is barium thioaluminate activated with europium.

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25. The method of claim 1, wherein said thin film phosphor composition is an alkaline earth thiooxyaluminate phosphor.

20 26. The method of claim 23, wherein said phosphor is further annealed at a temperature of about 700°C to about 1100°C.

27. The method of claim 26, wherein said phosphor is provided within a thick film dielectric electroluminescent device.

25 28. A composite sputtering target for use in deposition methods to deposit a thin film multi-element phosphor composition, said composite sputtering target comprising two component phases selected from the group consisting of;

- a matrix phase and an inclusion phase; and
- 30 - two matrix phases;

- wherein one of said phases comprises one or more metallic materials that contribute to the phosphor composition and the other of said phases comprises the remaining non metallic materials that contribute to the phosphor composition, said two component phases
5 being non reactive with each other prior to deposition

29. The target of claim 28, wherein said matrix phase comprises a metallic matrix of one or more metallic materials that contributes to the phosphor composition and said inclusion phase comprises one or more
10 non metallic materials that are chemical compounds that contribute the remaining elements of the phosphor composition.

30. The target of claim 29, wherein said metallic matrix is selected from the group consisting of a metal and thermally and electrically conductive
15 metal alloy.

31. The target of claim 30, wherein said metal is selected from the group consisting of aluminum, gallium and indium.

20 32. The target of claim 32, wherein said inclusion phase comprises one or more chemical compounds selected from the group consisting of sulfides, oxysulfides and oxides of an element from Group IIA or IIB of the Periodic Table of Elements.

25 33. The target of claim 32, wherein said inclusion phase further comprises an activator species of a rare earth metal.

34. The target of claim 33, wherein said metallic matrix is aluminum and said inclusion phase comprises a rare earth doped alkaline earth
30 sulfide.

35. The target of claim 29, wherein said composite target comprises a matrix phase provided as a metallic disc having an engraved surface of grooves containing said inclusion phase.
- 5 36. The target of claim 35, wherein said grooves are substantially parallel.
37. The target of claim 36, wherein said grooves are about 2-3 mm wide and spaced about 3 mm apart.
- 10 38. The target of claim 35, wherein said grooves are substantially concentric.
39. The target of claim 38, wherein said grooves are about 5-6 mm
15 wide and spaced about 2 mm apart.
40. The target of claim 29, wherein said inclusion phase is provided as a porous plaque with pores filled with said metallic matrix phase.
- 20 41. The target of claim 29, wherein said inclusion phase is provided as discrete metallic bodies selected from pellets and spheres in a non-metallic matrix phase.
42. The target of claim 28, wherein said composite target comprises a
25 metallic matrix phase and a non metallic matrix phase, said phases interpenetrating with each other.
43. A single source sputtering method for the deposition of a multi
30 element thin film phosphor composition onto a substrate, the method comprising;

a) providing a single composite target comprising two component phases selected from the group consisting of;

- a matrix phase and an inclusion phase; and

- two matrix phases;

5 - wherein one of said phases comprises one or more metallic materials that contribute to the phosphor composition and the other of said phases comprises the remaining non metallic materials that contribute to the phosphor composition, said two component phases being non reactive with each other prior to deposition;

10 b) placing said single composite target in a low pressure sputtering atmosphere comprising gases containing reactive species and non-reactive species; and

 c) applying sufficient power to said composite target and varying the pressure of said reactive species within said sputtering atmosphere to
15 control the sputtering rate of said matrix and inclusion phases of said composite target to cause the ratio of the elements in the two component phases to deposit in a desired ratio as a phosphor on said substrate.

20 44. The method of claim 43, wherein said pressure of said reactive species within said sputtering atmosphere is adjusted in accordance with the ratio of an exposed surface area of the two component phases of said composite target in an active sputtering zone to cause the ratio of the
 metallic and non metallic materials in said phases to deposit as a
25 phosphor film in a desired ration on a substrate.

 45. The method of claim 44, wherein said composite sputtering target is provided such that the ratio of an exposed surface area of the metallic materials to the non-metallic materials in the active sputtering zone
30 remains substantially constant during sputtering of said composite target and is in the range of about 0.1 to 0.7.

46. The method of claim 45, wherein said ratio is in the range of about 0.2 to 0.6.
- 5 4478. The method of claim 46, wherein said reactive species comprises hydrogen sulfide, atomic sulfur and/or diatomic sulfur.
48. The method of claim 47, wherein said non-reactive species comprises one or more inert gases.
- 10 49. The method of claim 48, wherein said inert gas is selected from the group consisting of argon, nitrogen and mixtures thereof.
50. The method of claim 49, wherein said pressure is about 0.05 Pa to about 0.3 Pa.
- 15 51. The method of claim 43, wherein sputtering is conducted at a power density of about 3 to 5 watts per cm².
- 20 52. The method of claim 43, wherein said metallic materials are selected from the group consisting of a metal and a thermally and electrically conductive metal alloy.
53. The method of claim 52, wherein said metal is selected from the group consisting of aluminum, gallium and indium.
- 25 54. The method of claim 52, wherein said non metallic materials comprise chemical compounds selected from the group consisting of sulfides, oxysulfides and oxides of an element from Group IIA or IIB of the Periodic Table of Elements and a rare earth element.
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55. The method of claim 54, wherein said rare earth element is selected from the group consisting of europium, terbium and cesium.

56. A single source sputtering method for the deposition of a multi
5 element thin film composition onto a substrate, the method comprising;

a) providing a single composite target comprising two component phases selected from the group consisting of;

- a matrix phase and an inclusion phase; and

- two matrix phases;

10 - wherein one of said phases comprises one or more metallic materials that contribute to the thin film composition and the other of said phases comprises the remaining non metallic materials that contribute to the thin film composition, said two component phases being non reactive with each other prior to deposition;

15 b) placing said single composite target in a low pressure sputtering atmosphere comprising gases containing reactive species and non-reactive species; and

c) applying a power density of about 3 to 5 watts per cm² to said composite target and varying the pressure of said reactive species within
20 said sputtering atmosphere to control the sputtering rate of said matrix and inclusion phases of said composite target to cause the ratio of the elements in the two component phases to deposit in a desired ratio as a thin film on said substrate.

25 57. The method of claim 56, wherein said pressure of said reactive species within said sputtering atmosphere is adjusted in accordance with the ratio of an exposed surface area of the two component phases of said composite target in an active sputtering zone to cause the ratio of the metallic and non metallic materials in said phases to deposit as a thin film
30 in a desired ratio on a substrate.

58. The method of claim 57, wherein said composite sputtering target is provided such that the ratio of an exposed surface area of the phase containing metallic materials to the phase containing non-metallic materials in the active sputtering zone remains substantially constant during sputtering of said composite target and is in the range of about 0.1 to 0.7.

59. The method of claim 58, wherein said ratio is in the range of about 0.2 to 0.6.

60. The method of claim 56, wherein said reactive species comprises hydrogen sulfide, atomic sulfur and/or diatomic sulfur.

61. The method of claim 60, wherein said non-reactive species comprises one or more inert gases selected from the group consisting of argon, nitrogen and mixtures thereof.

62. The method of claim 61, wherein said pressure is about 0.05 Pa to about 0.3 Pa.